METAL CASTING

Project Fact Sheet

Clean Metal Casting

Development of melt assessment and melt avoidance technologies for the casting industry

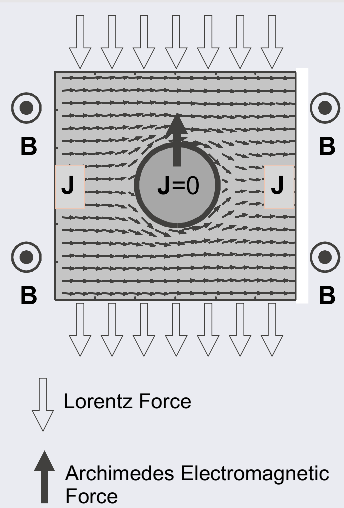
This research program, conducted at the Worcester Polytechnic Institute (WPI) Aluminum Casting Research Laboratory, is developing the technology base for clean metal processing on the foundry floor. The ability to produce consistent levels of melt cleanliness will allow industry to reduce scrap -- translating into increased productivity and competitiveness. The following reviews developments in *melt cleanliness assessment* and *melt contamination avoidance* research under this program. A separate fact sheet is available on high temperature phase separation technology.

Melt quality is comprised of three interrelated components: the control of trace elements, reduction of dissolved gas content, and removal of non-metallic inclusions. Inclusions in aluminum alloys reduce mechanical properties, are detrimental to surface finish, and increase porosity and corrosion. Non-metallic inclusions increase stress and can cause premature failure of a component. The detection of inclusions is difficult and often costly. WPI is developing an on-line melt cleanliness sensor designed to be affordable for the industry. The sensor's concept is based on the electromagnetic separation technique where an externally applied electromagnetic force acts upon the melt. In response to this externally applied force, the inclusions move in the opposite direction as a result of Newton's third law -- and thus are separated. WPI has demonstrated the feasibility of the concept and is developing the sensor to be tested in a foundry atmosphere.

WPI is also investigating and developing methods to avoid melt contamination that may occur during the melting and alloying processes and during transport of the metal. This includes investigating methods to reduce hydrogen absorption by the melt, as well as methods to reduce melt oxidation via the use of fluxes.

Electromagnetic Sedimentation

Current density, J, traverses left to right. There is no current in the inclusion since particles are non-conducting (J=0). The magnetic field, B, is applied in the direction out of the plane in the schematic. The resultant Lorentz force (cross product of J and B) is south. Inclusions experience an opposite (upward) force.



Archimedes electromagnetic force and Lorentz Force.

Benefits

Nearly 55% of the energy used in metal casting operations is for melting. Savings in this phase of the metal casting process will result in important energy and environmental benefits for the industry.

Currently, about 5% of all ferrous and non-ferrouse castings must be scrapped because of poor quality caused mainly by poor melt treatment practices. These inefficiencies waste an estimated $100 million per year in re-melting costs for the casting industry. The development and implementation of a viable clean metal casting technology will significantly reduce these costs for aluminum casters by reducing the incidence of defects that cause scrap and poor yields.

Applications

Preliminary results have already been well-received companies in the aluminum casting industry. Future research findings and technology development can be applied throughout the industry for virtually all aluminum castings.

Dissemination of research findings and guidelines is being conducted through the American Foundrymen's Society, the U.S. Department of Energy and by WPI researchers themselves.

DEPARTMENT OF ENERGY • UNITED STATES OF AMERICA

Project Description

Goal: The goal of this project is to develop a technology for clean metal processing that is capable of consistently providing a metal cleanliness level that is fit for a given application. Ultimately, it is designed to reduce the incidence of defects which cause scrap and poor yields, thereby reducing remelting costs. Among the tasks included in this project are:

1) The development of melt cleanliness assessment technology
2) The development of melt contamination avoidance technology
3) Development of high temperature phase separation technology
4) Establishment of a correlation between the level of melt cleanliness and as-cast mechanical properties
5) Transfer technology to industry

This fact sheet discusses Tasks 1 and 2, melt cleanliness assessment and melt contamination avoidance.

Progress and Milestones

Task 1: Melt Cleanliness Assessment

- A gauge repeatability and reproducibility analysis was performed on the Reduced Pressure Test to evaluate and to categorize the effects of various test conditions on RPT results. It was determined that the RPT is not an acceptable method for quantitatively evaluating the hydrogen content of aluminum alloys.

- The feasibility of the concept of a sensor based on the electromagnetic separation technique has been demonstrated.

- Development of a melt cleanliness sensor is in progress.

Task 2: Melt Contamination Avoidance

- A comprehensive and critical literature review of hydrogen in aluminum alloys has been compiled.

- An experiment has been designed in conjunction with FOSECO to examine the effect of chlorine and fluorine on the effectiveness of fluxes. Several fluorine and chlorine-free fluxes will be designed and investigated.

Project Partners

American Foundrymen's Society, Des Plaines, IL

FOSECO, Cleveland, OH

Hitchcock Industries, Minneapolis, MN

Kennedy Die Castings, Inc., Worcester, MA

Madison-Kipp Corp., Madison, WI

Palmer Foundry, Palmer, MA

Selee Corporation, Hendersonville, NC

Stahl Specialty Company, Kingsville, MO

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